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Invention disclosure and Inventor registration

Enclosures

1. Invention Disclosure (23 pages)
2. Inventor Registration (2 pages)

Dear Caroline,

Please attached find the Invention Disclosre and Inventor Registration signed by the inventors.

Best regards

Preda Gábor

Gabor Preda

Patent Engineer

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INVENTION DISCLOSURE

1 Title of the Invention

Advanced Performance Management of Mobile Data Networks

2 Background

2.1 Technical Background/Existing Technology

The performance management of cellular mobile data networks (GPRS, UMTS, CDMA2000) gets more and more important as the number of subscribers starts to pick up, the traffic on these networks increases and subscribers start to use more and more different applications and services. There is a need for performance management solutions, which makes it easy to find out when there is a performance problem in the network, but it has the same importance to find out the location of the performance problem. Such a performance management system should help the operator in the following areas:

- Performance analysis (Do users get what they paid for or what they expect?)
- Bottleneck analysis (What are the bottlenecks in the network?)
- System improvement (After identifying the causes of performance problems, try to enhance the system such that these problems get eliminated.)
- Dimensioning (Which cells, links, etc need to be re-dimensioned, and how?)
- Etc.

In case of a circuit switched service (such as e.g., voice), it was basically enough to measure the call intensities, call durations and the ratio of blocked calls. In case of packet switched services (e.g. Web, WAP, FTP, e-mail, MMS, etc.) the above tasks are not at all trivial, because the end-to-end (or user perceived) performance depends on the interaction of many protocols at different interfaces and on various protocol layers. Furthermore, the use of shared resources leads to rather complicated queuing phenomena, which are difficult to model and analyze.

In current GSM, GPRS, CDMA2000 and UMTS networks, the service area is divided into cells covering limited geographical areas. The aim of the mobile operator should be to provide a constant and ubiquitous high quality service regardless of the location of its subscribers. This is a very challenging task for example because subscribers tend to be distributed non-homogenously across the service area.

2.1.1 Determining User Perceived Quality using Passive Monitoring in Packet Switched Systems

Passive measurement based characterization of IP [TCPloss] as well as GPRS networks has already been carried out.

For example, in case of GPRS [GPRS_meas] packets on the Gi interface have been captured. The Gi interface connects the Gateway GPRS Support Node (GGSN) with external packet data networks (such as e.g., an ISP). Based on the Gi traffic traces detailed traffic and end-to-end performance analysis results has been delivered to operators. At the same measurement point where Gi traffic can be captured, the messages to/from the RADIUS server can typically also be captured The RADIUS packets can be used to reconstruct user sessions.

2.1.2 Performance Counters for GSM/GPRS cells

Statistics and Traffic Measurement Subsystem in the Ericsson BSS records some key radio network events [STS,STS9.1]. These counters provide information about the performance and traffic load in specific cells. The following list exemplifies what sort of information the operator can obtain from these counters:

1. The number of connections successfully established on the TCH.
2. For every cell there are counters for the number of allocation attempts. They are incremented at every attempt to allocate a TCH in a resource type in the cell, to be used for signalling, data or speech, regardless of whether the allocation succeeded or failed.
3. A counter shows the accumulated number of available (i.e. idle and busy) Basic Physical Channels used for traffic in a cell.
4. Number of Offered Incoming Calls.
5. Number of Offered Normal Originating Calls.
6. A counter is stepped each time the BSC attempts to allocate a set of one or more PDCHs from the circuit switched domain.
7. Accumulated number of allocated PDCHs.
8. The peak number of active PDCHs from the last 15 minutes.

9. The total number of RLC data blocks transmitted by the PCU during the measurement period.

10. The total number of RLC data blocks retransmitted by the PCU during the measurement period.

11. Accumulated number of TBFs per traffic combination of UL/DL.

12. Accumulated number of PDCHs carrying at least one TBF per traffic combination of UL/DL and GPRS/EGPRS.

Counters are collected every 5 or 15 minutes. This is the Basic Recording Period, which can be set by command and is recommended to be 15 minutes. Measurement data for the Basic Recording Period is accessible in the database for two hours.

2.1.3 Drive Tests

In this set-up, special purpose terminals are used, which run a given application. The terminal is operated by a test user and it runs an application, which is under test.

In case of cellular mobile data networks, the terminal can for example be installed on the board of public transport service bus or a taxi. The application is run repeatedly, and the performance results together with the cell level location of the test are recorded. This way performance results are obtained for the cells, which have been visited during the drive test.

2.2 Problems with existing solutions

In order to efficiently monitor and manage cellular mobile data networks, two type of information is necessary:

1. User perceived end-to-end performance of different applications

2. Information about the resource usage and performance in the different cells

The need for the first type of information is obvious, the reason for requiring this information on cell level is that cells are the basic dimensioning units of cellular data networks, congestion typically occurs because the resources of a particular cell are exhausted, and the performance problem can most often be alleviated by adding additional resources (e.g. a couple of new traffic channels) to the problematic cell.

As mentioned in the previous sections, advanced passive measurement based methods are available to characterize the user perceived end-to-end performance of different applications in case of GPRS networks, but these methods currently work on a whole network basis and it is not currently possible to obtain the key performance indicators on cell level.

The problem with the monitoring systems developed for the Internet is that they miss an important abstraction level, which is key to a mobile operator, and that is the level of the mobile subscriber. IP addresses (and IP application transactions) need to be associated with the mobile subscriber they belong to, which can not be done with a traditional IP network monitoring system.

There is a set of counters available in the Ericsson BSS to obtain performance results on cell level. It is clear from the above list that these counters can be used to understand the cell level performance of circuit switched services but they does not tell much about the user perceived end-to-end quality of service of packet switched applications and services.

Other problem with the counters is that other system vendors might implement other counters, which makes it impossible to build a coherent performance monitoring system in a multivendor network. Furthermore, the maintenance of these counters puts a significant load on the BSC node, therefore performance results are available only with a very coarse grained time resolution.

Most important problem with the third performance monitoring alternative, the drive test is that it is not scalable. It generates additional load over the network and it requires significant time to cover a large area with enough measurements to allow obtaining statistically reliable measurement results, not to mention the difficulty of generating realistic application level traffic patterns in such an artificial use case.

To summarise, we miss a passive performance monitoring solution, which

1. provides information about the true, user perceived end to end performance of mobile data networks,
2. it provides this information on cell level,
3. it is scalable, and
4. it is vendor independent.

To build such a passive performance monitoring system for cellular data networks is not trivial because the information, which is necessary to be collected, can not be obtained at a single measurement point.

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3 Basic Concept

This invention disclosure outlines a solution, which meet all of these four criteria identified above. A method and a system is presented, which enables efficient and detailed characterization and performance management of particular cells in a cellular mobile data network. A set of key performance indicators which describe the true, user perceived end to end quality of the most commonly used applications are also listed. Such a method greatly improves the performance and service management of cellular mobile data networks, given that the operator can easily find out if the performance of a cell does not meet the user's expectations and can immediately act where the problem is. The key element of the system is to build a traffic and session database by correlating traffic and mobility information extracted from passively captured traces, which can be collected from multiple standardized interfaces.

Keywords: correlating information from multiple network traces, reconstructing user sessions, building a condensed traffic database, passive monitoring, cell level key performance indicators

4 Detailed description

4.1 Detailed Technical Description of the Invention

4.1.1 The solution

The method is composed of four main steps:

1. Capturing raw traffic traces over standardized interfaces of an operational cellular mobile data network

2. Parsing through the traces in order to extract and correlate all the information, which is needed to build a traffic database. This traffic database contains information about each and every user session and user transaction which happened during the measurement period

3. Defining a set of appropriate key performance indicators, which can be used to characterize the performance of cells in terms of user perceived quality of service parameters

4. Calculating the above defined key performance indicators by selecting an appropriate subset of the transactions in the traffic database, and calculating the key performance indicator value by summing/averaging the given QoS measure of the selected individual transactions.

4.1.1.1 Step 1: Capturing the traffic traces

The first step is to look at the architecture of the cellular mobile packet data network and to look at the protocol stacks over the standardized interfaces. The result of this investigation is a set of interfaces, which need to be captured in order to have all the information necessary for the traffic database available. All the IP packets of all (or at least a significant portion to ensure statistical reliability of the results) of the user transactions need to be captured together with the session and mobility management signaling of the users. If the above information needs to be captured at multiple interfaces, it is required to have at least one unambiguous identifier of the user present in all the traces. An additional requirement is to record a timestamp with each captured packet.

4.1.1.2 Step 2: Building the traffic database

The second step is to build the traffic database. The process is depicted in Figure 1. IP packets from the captured traces are processed one by one and the packets belonging to the same application transaction of the same user are grouped together. These groups can be created by looking at the <source IP address, destination IP address, source port, destination port> fields in the IP header. Applications can be identified by looking for the standard port numbers. (E.g.: TCP port 80 for Web traffic.) Depending on the application logic, identified packet groups can be further divided into user transactions like TCP connections, HTTP object downloads, WAP object downloads, and so on. After having all packets of a particular transaction collected, condensed information like the start, end, duration, amount of data in uplink and downlink, success, failure of the transaction is generated.

Further difficulty is to associate subscribers with the condensed application transactions information collected above. In mobile packet data networks there are signaling messages to initiate a subscriber data session. In these signaling exchanges, a subscriber identifies itself by one of its unique identifier in the mobile system (for example its International Mobile Subscriber Identity) and the system answers with an IP address, which the mobile can use for its application transactions. By parsing through these signaling messages, the required association between subscribers and their transactions can be established. The Quality of Service parameters requested for the subscriber data session can also be extracted from the signaling messages.

The only missing link now is the association between the user transaction and its cell level location. In mobile data networks, typically when there is an active user data session and typically at interfaces in the radio access network of the system, there is signaling when the mobile changes cell. In these signaling messages a (sometimes temporary but unique) identifier of the subscriber is sent together with its new cell level location. If the identifier in these signalling exchanges is temporary, then the signaling exchange in which the subscriber identified with a permanent unique identifier gets its temporary unique identifier needs also to be interpreted. This results in a

database containing the permanently unique identifier of the subscriber together with cells it visited, and the timestamp when the visit happened. Using this data, the condensed transaction information is extended with the cell level location of the transaction and an indicator of cell change during the course of the transaction. Finally, summary data (type and number of transactions, total number of uplink and downlink traffic, Quality of Service profile) is generated about the transactions belonging into the same user session, and it is stored together with the list of cells visited during the session and the timestamp of the visits.

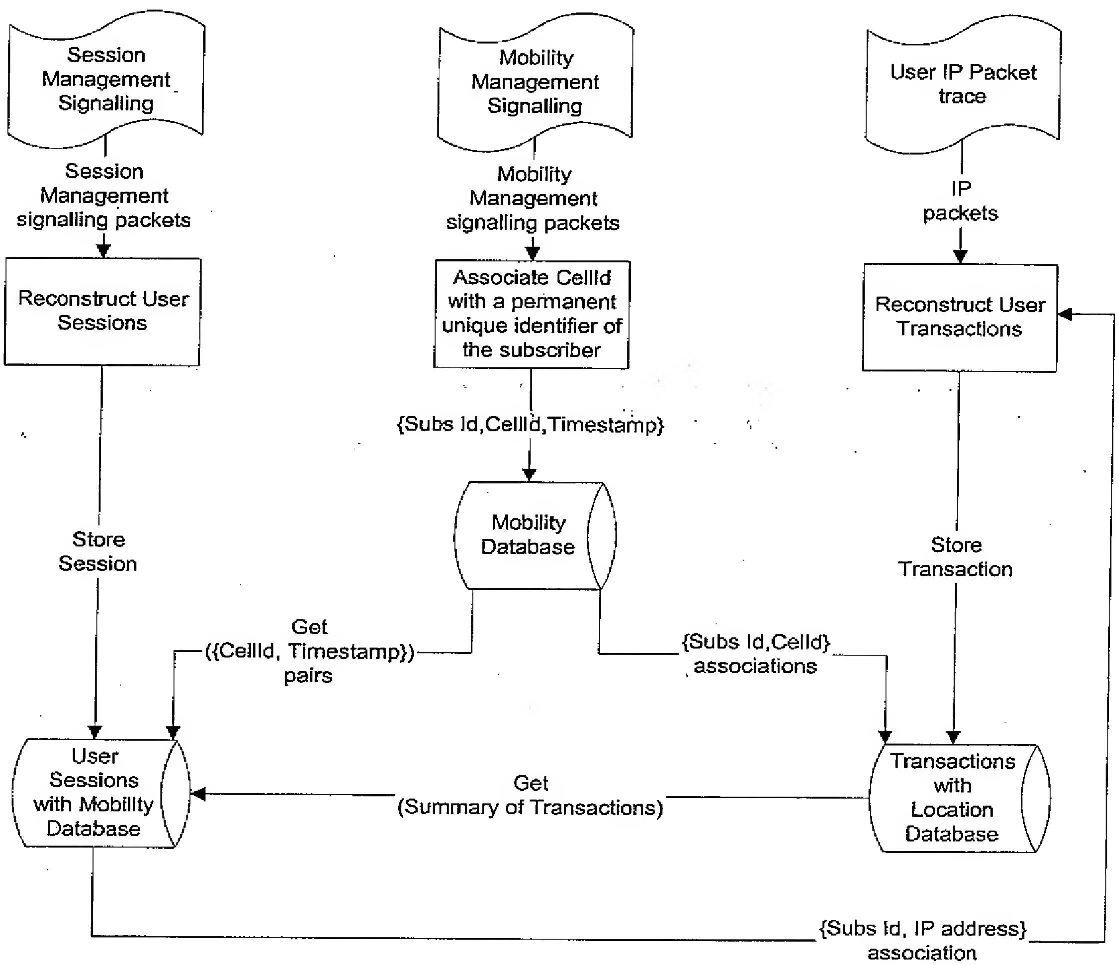

Figure 1. Building the traffic database

4.1.1.3 Step 3: Defining the Key Performance Indicators

The following key performance indicators are used to characterize the performance of a cell in mobile packet data networks:

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MMS large message download/send rate in a specified cell

Given in bit/sec, these KPIs define the average transmission rate during sending or downloading of large MMS messages. Only successful transactions are considered whose size is larger than a given amount of bytes. Recommended value is 5 kbytes. The rate is calculated as the total IP-layer transmitted/received bytes divided by the total duration of the transaction. A size limit is included to eliminate transient effects of short messages.

WAP object download delay in a specified cell

The average delay between the request packet from the mobile until the server response is successfully acknowledged by the mobile. Precondition: successfully finished download.

Web small object download time (9-11kbyte) in a specified cell

The average time it takes to download a small HTTP object. Only small (9-11 Kbytes) files are measured. Due to the TCP protocol, small objects are not able to utilize the full capacity available in the cell. The download time of such small objects depends more on the round-trip time. To have comparable results between different measurements and cells, only objects that fall into a narrow range are measured. The chosen range of 9-11 kbytes was chosen because the median of Web downloads falls in this range. Condition: object download was successful.

Web large object download rate (larger than 50kbyte) in a specified cell

The average rate is the size of the object divided by the time it takes to successfully download the object. This measure is also called *goodput*. Only large objects are measured, when the available end-to-end path capacity dominates the measure and not the object size. Condition: object download was successful.

FTP download rate (larger than 50kbyte in a specified cell)

The average rate is the size of the downloaded file divided by the time it takes to download it. Only large files are measured, when the available end-to-end path capacity dominates the measure and not the file size. Condition: file download was successful.

POP3, mail download time (9-11kbyte) in a specified cell

This KPI defines the average time to successfully download one or more e-mails from the POP3 e-mail server. The whole time is measured including server greeting, authentication, and time to download of all mails and quit. Condition: mail download was successful, and the total downloaded amount of bytes is small (between 9-11kbytes).

POP3, mail download rate (larger than 50kbyte) in a specified cell

This KPI defines the average rate during successful download of one or more e-mails from the POP3 e-mail server. The rate is measured during the whole time including server greeting, authentication, and time to download of all mails and quit. Condition: mail download was successful, and more than 50kbytes was downloaded.

End-to-end achievable throughput in a specified cell

This KPI measures the average achievable IP layer throughput end-to-end. This KPI is measured by tracing those mobiles that generate one or more parallel TCP downloads saturating the downlink channel. In an optimally configured network this KPI shows the available data transfer capacity in the cell.

Rate of TCP Connections, Stalled Periods in a specified cell

This KPI gives the average rate achieved by greedy TCP flows, as well as the frequency of stalled periods within them.

User-Perceived Throughput History in a specified cell

This KPI gives the throughput limitation users perceive as a function of time. It can be used for Service Level Agreement validation. It is based on the throughput of greedy user session segments. Optionally, the variance and quantiles can also be given.

In addition to these values, it is necessary to determine the share of different traffic types in the cells. This means calculating the accumulated traffic of the flowing protocols: TCP, UDP, ICMP, HTTP, FTP, WAP, SMTP, DNS, POP3, IMAP4, and Telnet.

Using the information captured in the traffic database described in 4.1.1.2 additional key performance indicators can be defined.

4.1.1.4 Step 4: Obtaining the Key Performance Indicators

The procedure for calculating the above listed key performance indicators is as follows:

1. Read the next transaction record from the traffic database.
2. Check whether this transaction is of the type, which the KPI is about. This can be done using the flow type field of the transaction record.
3. Check whether the transaction happened in the cell specified for the KPI. This can be done using the Cell Id field of the transaction record.

4. Calculate the quantity defined by the KPI for the particular transaction. Information elements used are: duration, timestamp of the first data packet, timestamp of the last data packet, packet count and loss count fields of the transaction record.

5. Add the value to an aggregation counter, and increase the counter calculating the number of eligible transactions for the KPI.

6. Go back to step 1 until all the transactions are processed.

7. Calculate the KPI value by dividing the value of the aggregation counter with count of the eligible transactions.

4.1.2 A preferred embodiment of the solution in GPRS networks

4.1.2.1 Capturing of the raw traffic traces

In the specific case of GPRS networks, the following interfaces provide data, which is useful when building the traffic database. Depending on the configuration of the particular network, simultaneously captured traffic traces are needed for the method to operate from one or more of the below listed interfaces. See Section 4.1.2.2 for processing details in case of different trace combinations.

Gb interface interconnects the BSS with the SGSN. It carries GPRS Mobility Management and GPRS Session Management signaling together with the data packets of the users. It is a Frame Relay interface, but many protocol analyzers (Nettest, Radcom, Nethawk, Tektronix) are available on the market to capture all traffic from one or more Gb interfaces into a dump file.

Gn interface interconnects the GPRS Support Nodes (SGSNs and GGSNs). It carries GPRS Session Management signaling together with user data packets. Both data and signaling packets are transported over GPRS Tunneling Protocol (GTP). This interface is typically a standard IP (Ethernet) interface so freeware tools like TCPDump can be used to capture traffic from the Gn interface into a dump file.

Gi interface interconnects the GPRS network (GGSN) with an external IP network. This interface is typically a standard IP (Ethernet) interface so freeware tools like TCPDump can be used to capture traffic from the Gi interface into a dump file. In order to be able to track PDP sessions, RADIUS messages are also need to be captured in addition to the user data packets.

Gr interconnects the SGSN with the HLR. Many protocol analyzers (Nettest, Radcom, Nethawk, Tektronix) are available on the market to capture traffic from Gr interfaces into a dump file.

4.1.2.2 Building the traffic database

Building the traffic database from a Gb trace

The following information can be extracted from protocol data units captured over the Gb interface [BSSGP]:

Cell ID of each and every active user: BSSGP UL-UNITDATA PDU transfers an MS's LLC-PDU and its associated radio interface information across the Gb-interface. Part of this PDU is the Cell ID.

GPRS Multi Slot Class: The purpose of the *Mobile Station Classmark 4* information element is to provide the network with information concerning aspects of the mobile station related to GPRS. Among many other things this information element contains data about the GPRS Multi Slot Class. Mobile Station Classmark 4 information element is present in Attach Request messages. Another information element *MS Radio Access Capability* also contains the GPRS multiclass information. This information element is present in DL-UNITDATA.

The relationship between the different information elements available in the Gb trace, the required processing steps and the resulting databases are depicted in Figure 2.

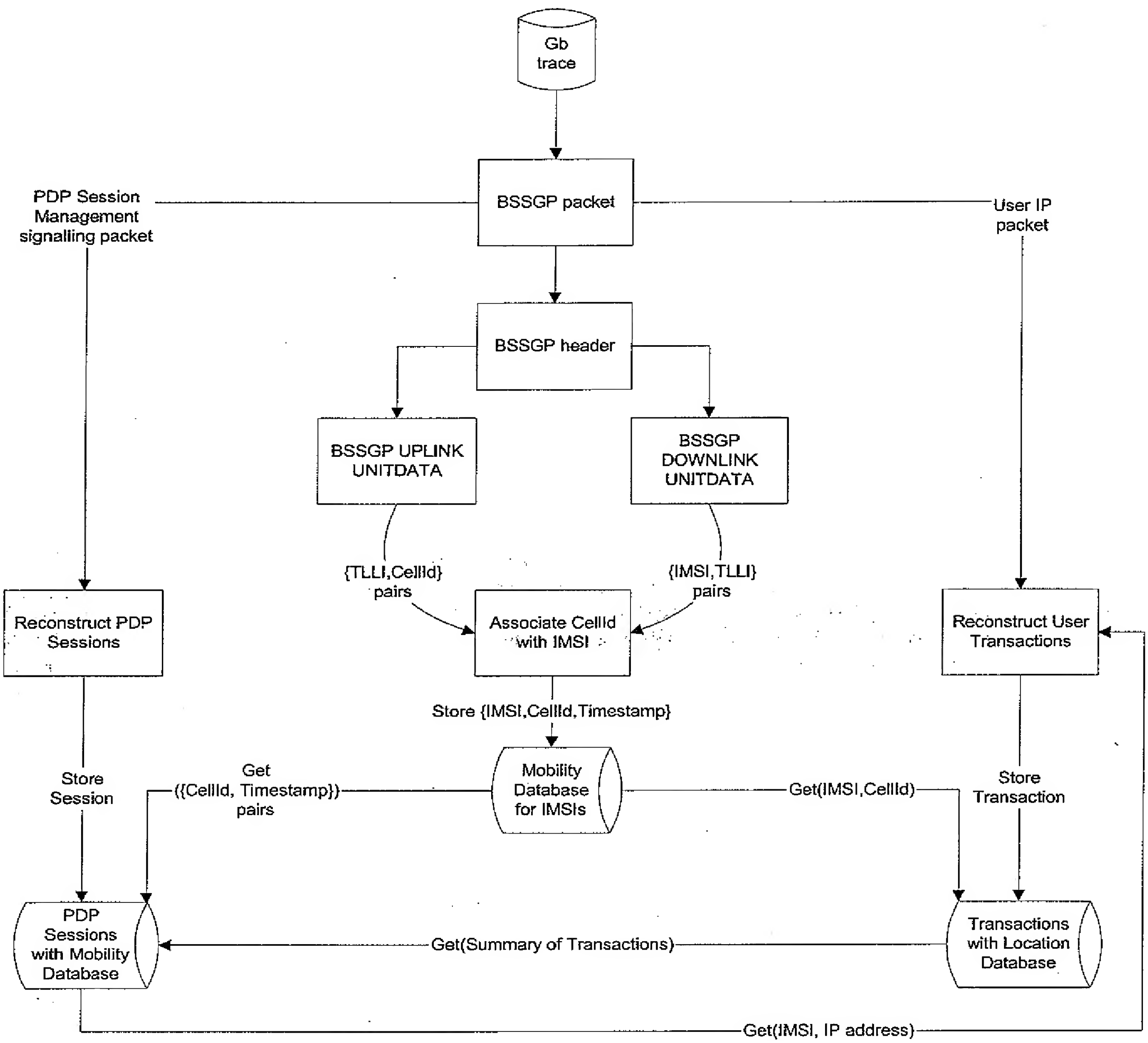

Figure 2. Building the GPRS Traffic Database from a Gb Trace

BSSGP DOWNLINK UNITDATA PDU contains IMSI and MS Radio Access Capability, together with the TLLI, and the old TLLI whenever TLLI changes. BSSGP UPLINK UNITDATA PDU carries the TLLI and the Cell ID. The following algorithm can be used to extract the mobility data:

1. Whenever a DOWNLINK UNITDATA PDU is encountered in the trace, check whether it contains a new IMSI

- If a new IMSI is encountered register it, together with the corresponding TLLI and timestamp.
- If an already known IMSI is encountered, check whether TLLI change is indicated.
- If TLLI change is indicated, register the new TLLI as belonging to the old IMSI

2. Whenever an UPLINK UNITDATA PDU is encountered in the trace, look up the IMSI database mentioned above to find out the IMSI which the TLLI belongs to.

3. Check whether the Cell ID is identical to the last one registered to the IMSI in the database.

   - If a new Cell ID is found, register it to the IMSI together with the timestamp of the BSSGP PDU.

Whenever an IP packet carrying user data is found in the BSSGP packet, it is used for reconstructing the user transactions. A transaction is coherent traffic between two endpoints, identified by IP address and ports (only for TCP and UDP). The delimitation of transactions is protocol-specific, for example, it is a connection in case of TCP, it is a request/response pair in case of a DNS query. Whenever packets of a new transaction are collected from the packet stream, a new record is created containing the following information:

- The timestamp of transaction start;
- Flow type, Inner and outer addresses; Inner and outer ports;
- Protocol number;
- Numeric identifier of the user session;
- Transaction duration in seconds from start to last activity;
- Number of packets in and out; Number of bytes in and out;
- IP layer rates in both directions (bits per second);
- Protocol-dependent statistics.
- IMSI of the user;
- Cell Id at the start of the transaction,
- Flag whether the user has changed cell during the transaction

- MS Class of the terminal;

Parallel with above described processing of the BSSGP header and user IP packets, the PDP session management signaling contained in the BSSGP packets is also processed. Based on the ***Create PDP Context Request***, ***Create PDP Context Response*** signaling messages and the condensed transaction records, PDP session records are created which store the following information about the new PDP session:

- Starting timestamp; addresses and port numbers;
- Numeric identifier referenced from the user transactions database;
- Duration; Number of transactions involved;
- Number of packets and bytes transmitted for both directions;
- Number of transactions on different network and application protocols.
- IMSI of the user
- IP address allocated for the session
- QoS profile
- List of {CellId, Timestamp} pairs tracking the mobility of the user during the session

Building the traffic database from an encrypted Gb and Gr trace

Operators often encrypt their Gb interface, which hide the data and session management signalling above the LLC protocol layer. The solution in this case is to capture simultaneous trace over the Gr interface, look up the user specific Kc encryption key in the Gr trace and use the standardised encryption algorithms to decrypt the Gb traffic [Security]. After decryption, the process is identical to the one described in previous section. The process is outlined in Figure 3.

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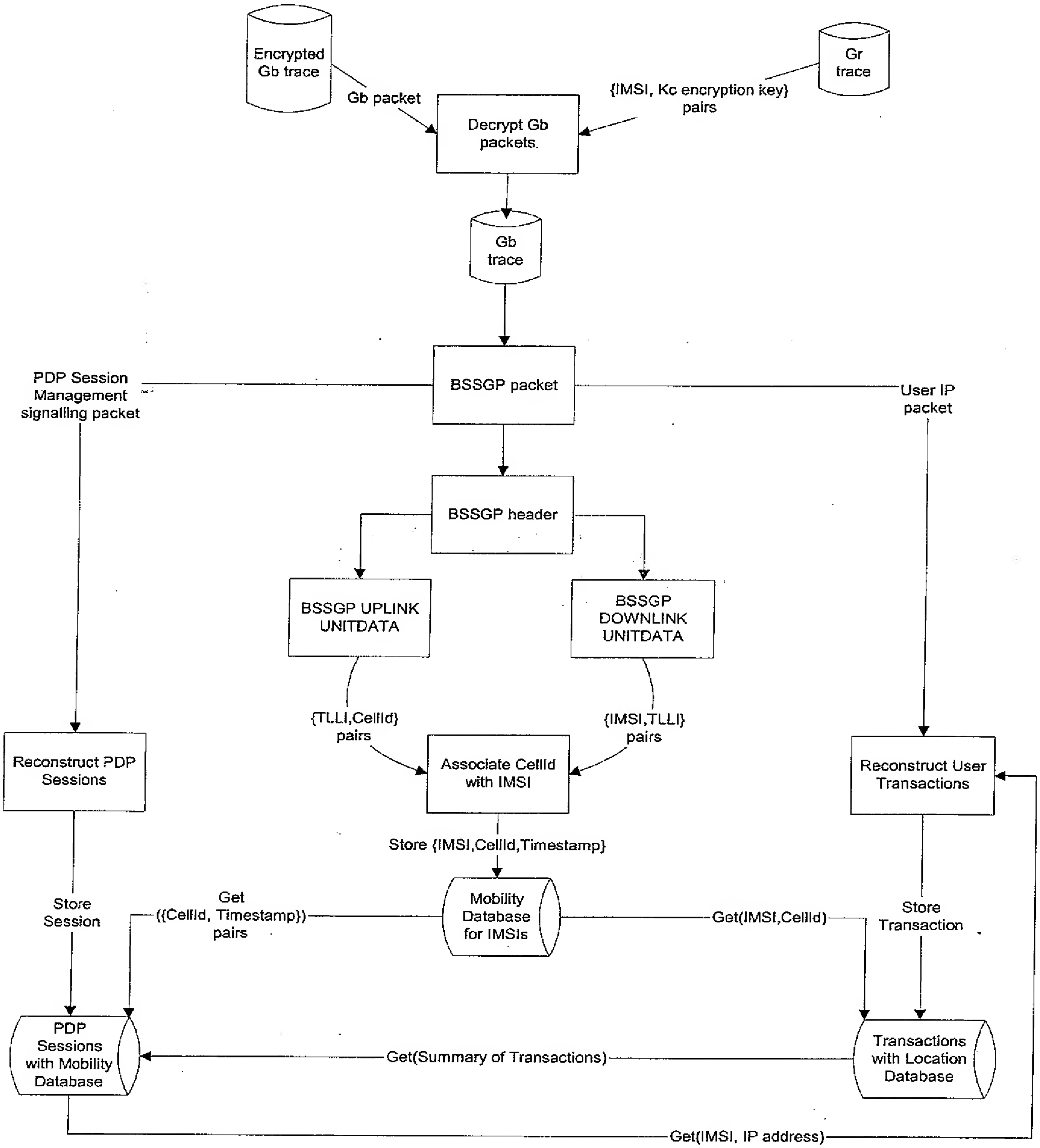

Figure 3. Building the GPRS Traffic Database from an Encrypted Gb and a Gr Trace

Read and Understood by: ......Prisha Gaba......	Date:....2003-08-29....
Read and Understood by:	Date:..

Building the traffic database from an encrypted Gb and a Gn trace

If the Gb trace is encrypted, it is encrypted at the LLC layer. This means that mobility management information can still be obtained from the BSSGP protocol header. The PDP session control signalling messages are present in the Gn trace together with all the user data packets. IP packets of the user data are extracted from the GTP tunnelling packets, and not from the BSSGP UNITDATA packets. The process is depicted in Figure 4.

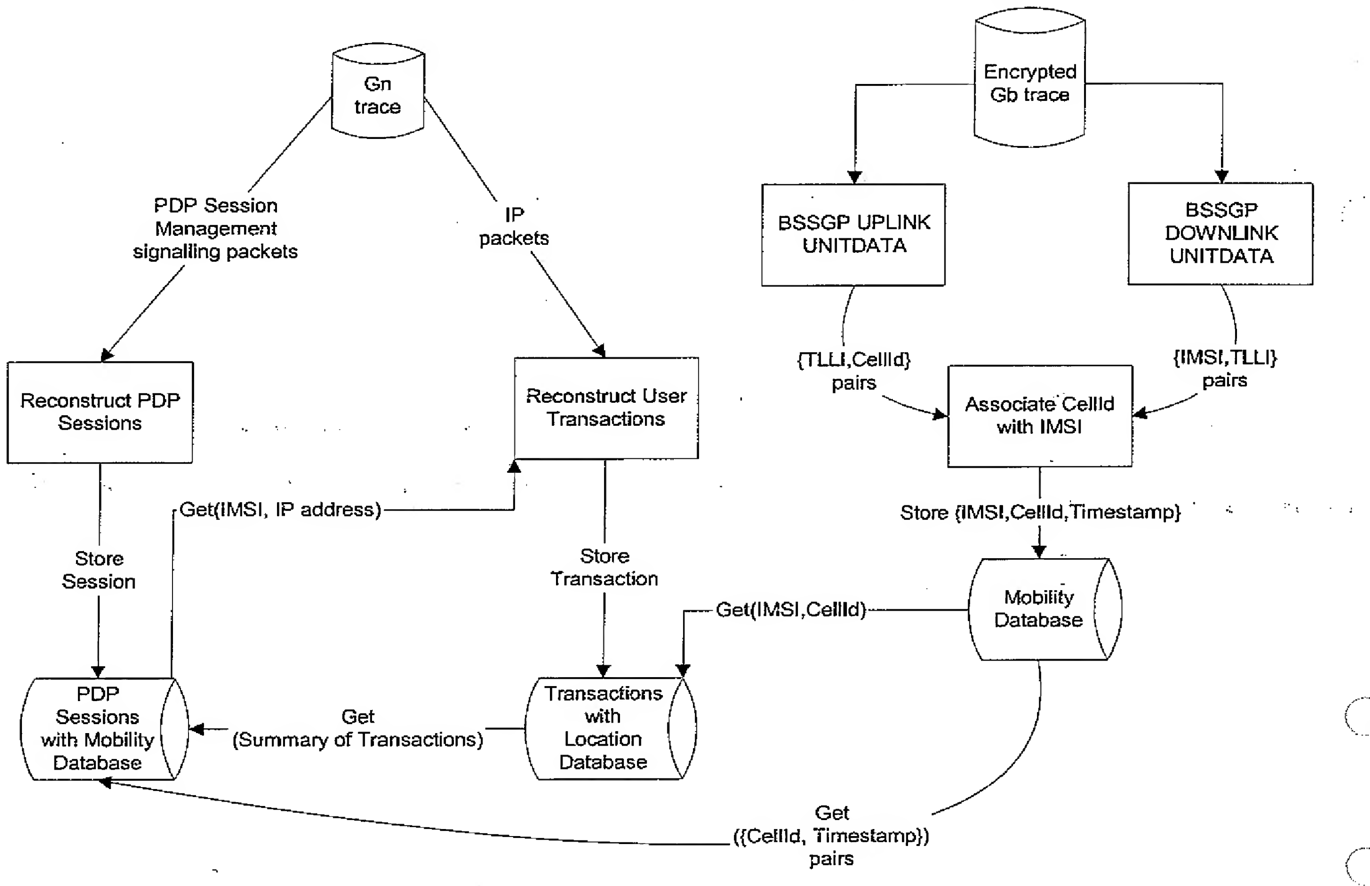

Figure 4. Building the traffic database from an encrypted Gb and Gn trace

Building the traffic database from an encrypted Gb, Gi, RADIUS trace

It is possible to use Gi traces provided that the Gi trace is amended with the RADIUS packets. Further requirement is that the optional, vendor specific parameter IMSI is present in the RADIUS messages [RADIUS]. A RADIUS request will indicate the start of a PDP session and trigger the construction of a new session record. The user will be identified in the RADIUS packets by the IMSI therefore the mobility pattern found in the Gb trace can be associated with the user sessions and transactions found in the Gi/RADIUS trace.

Building the traffic database from an encrypted Gb, Gi, RADIUS trace and an {MSISDN,IMSI} list

It is possible to use Gi traces provided that the Gi trace is amended with the RADIUS packets (No optional IMSI in RADIUS packets!), and there is a database containing the list of {IMSI,MSISDN} pairings for the users. A RADIUS request will indicate the start of a PDP session and trigger the construction of a new session record. The user will be identified in the RADIUS packets by an MSISDN. To be able to associate the mobility pattern found in the Gb trace with the user sessions and transactions the corresponding IMSI needs to be looked up in the {IMSI,MSISDN} database. This option is depicted in Figure 5.

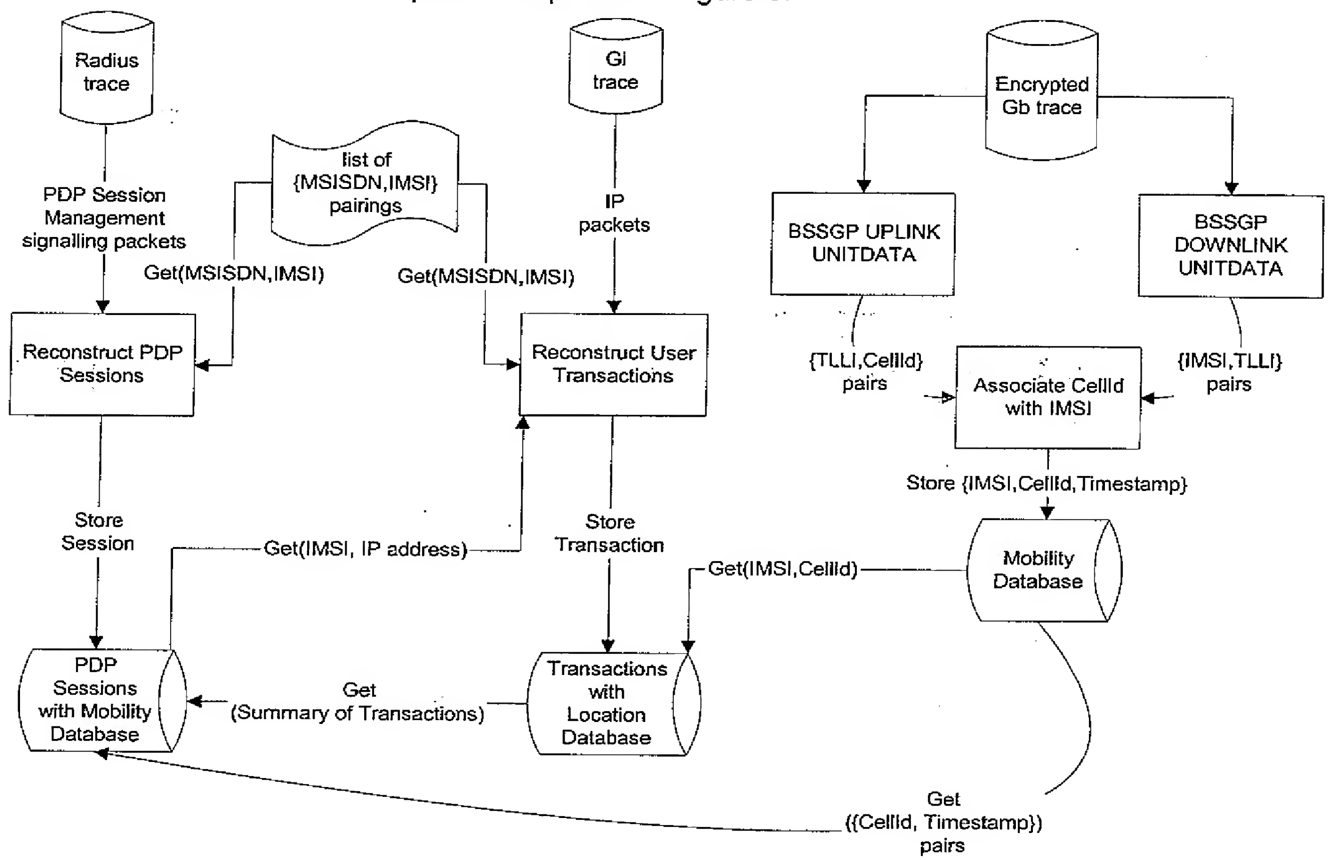

Figure 5. Building the traffic database from an encrypted Gb, Gi, RADIUS trace and an {MSISDN,IMSI} list

Building the traffic database from an encrypted Gb, Gi, RADIUS trace and a fractional Gn trace

If there is any sort of Gn trace available, not necessarily simultaneous with the Gb and Gi trace, but covering the same network segment, it can be used to automatically build a large enough database of {IMSI, MSISDN} pairs:

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- If GTP version used over the Gn interface is v0, the IMSI is contained in every message header as part of the Tunnel ID filed, while the MSISDN is present as a mandatory parameter in Create PDP Context Request messages.
- If GTP version used over the Gn interface is v1, both the IMSI and the MSISDN is contained as a conditional parameter in Create PDP Context Request messages.

Using this list of {IMSI, MSISDN} pairs, the procedure of the previous section can be applied. This alternative is depicted in Figure 6.

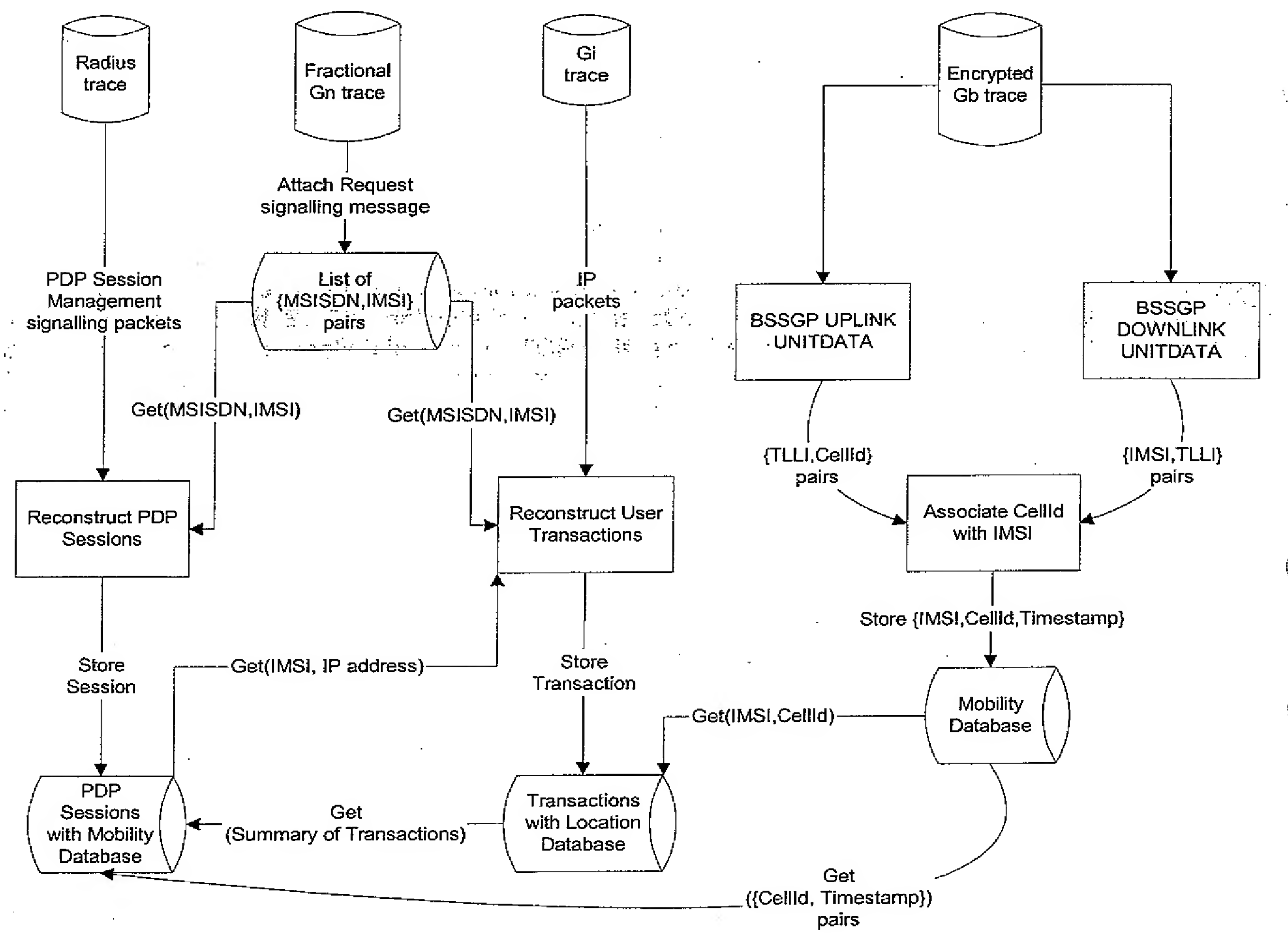

Figure 6. Building the traffic database from an encrypted Gb, Gi, RADIUS trace and a fractional Gn trace

Read and Understood by: .... (signature)	Date: 2003-08-29
Read and Understood by:	Date:...

4.1.3 Defining the set of key performance indicators

The key performance indicators listed in Section 4.1.1.3 are suitable for the specific case of GPRS networks.

4.1.4 Calculating the value of the key performance indicators

The process described in Section 4.1.1.4 can be used for calculating the key performance indicators from the GPRS traffic databases.

4.2 Advantages of the Invention

A method for passive measurement based characterization of mobile packet data networks is proposed which makes possible for the operator to obtain key performance indicators to describe the user perceived end to end performance of different applications, and the measurement results are associated with specific cells. The proposed method therefore not just indicates a performance problem but also pinpoints the location of the problem.

The proposed solution uses raw measurement data available from standardized network interfaces which has two important advantages:

1. vendor independent
2. easy to obtain enough measurement data to calculate results with statistical significance

Cellular mobile packet data operators when trying to increase the revenue they obtain from packet switched services face a significant challenge. They need to attract business users to cash in a big amount of money, but business users require a robust, reliable service, which offers quality of service guarantees. One way to overcome this problem is to define a service level agreement, which outlines what sort of guarantees the subscriber can expect from the network. For such an agreement to be convincing for the potential customers, it shall be written in terms of the user perceived performance indicators. The monitoring method described in this document is a tool for the operator to offer such new, value added services, because it gives a cheap, easy to implement way of monitoring and tracking the guarantees put forward in such a service level agreement.

The solution readily lends itself for application in GPRS, which is the most widely used mobile packet data network technology today. A preferred implementation of the solution in GPRS networks is also detailed.

The database used by the GPRS specific embodiment of this invention differs from the database proposed in [GPRS_meas] in the following significant ways:

- A field is added to each transaction record showing the identifier of the cell, which the transaction commenced in.

- A field is added to each transaction record showing a binary value indicating whether cell change has happened during the transaction.
- A field is added to each transaction record showing the multislot class capability of the terminal, which carried out the transaction.
- A field is added to each transaction record containing the IMSI of the subscriber, who carried out the transaction.
- A field is added to each user session record containing the IMSI of the subscriber, who the user session belongs to.
- A variable length field is added to each user session record showing the list of *{cell identifier, timestamp}* pairs for each cell change, which occurred during the user session.

Further advantage of the method is that it does not rely on a particular trace when constructing the traffic database but it is capable of obtaining and correlating the required information from a set of different trace combinations of standardized Gb, Gi, Gn, and Gr GPRS interfaces. This makes the method applicable for most of GPRS networks which are run today regardless of their salient configuration settings.

5 Abbreviations

BSC	Base Station Controller
BSS	Base Station System
BSSGP	BSS GPRS Protocol
CDMA	Code Division Multiple Access
DNS	Domain Name System
FTP	File Transfer Protocol
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio Service
GTP	GPRS Tunneling Protocol
HLR	Home Location Register
HTTP	Hypertext Transfer Protocol
IE	Information Element
IP	Internet Protocol
IMSI	International Mobile Subscriber Identity
ISP	Internet Service Provider
KPI	Key Performance Indicator
LLC	Logical Link Control
MMS	Multimedia Message Service
MS	Mobile Station
PCU	Packet Control Unit
PDCH	Packet Data Channel
PDP	Packet Data Protocol
PDU	Protocol Data Unit
POP	Post Office Protocol
QoS	Quality of Service
RADIUS	Remote Authentication Dial-In User Service
RLC	Radio Link Control
SGSN	Serving GPRS Support Node

Prepared (also subject responsible if other)		Document Nr.		
ETH/RT Szabó, Borsos, Veres, Malomsoky		1/ETH/RL-2003:0133		
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ETH/RTC Hans Eriksson		2003-08-28	A	

STS	Statistics and Traffic Measurement Subsystem
TCH	Traffic Channel
TCP	Transmission Control Protocol
TLLI	Temporary Logical Link Identity
TRU	Transciever Unit
UMTS	Universal Mobile Telecommunication Service
UDP	User Datagram Protocol
WAP	Wireless Application Protocol

6 References

[BSSGP] General Packet Radio Service (GPRS); Base Station System (BSS)-Serving GPRS Support Node (SGSN);BSS GPRS Protocol (BSSGP) (GSM 08.18 version 8.9.0 Release 1999)

[GPRS_meas] http://trafficlab.ericsson.se/RL/traffic_modelling/GPRSbottleneck.shtml

[RADIUS] General Packet Radio Service (GPRS); Interworking between the Public Land Mobile Network (PLMN) supporting GPRS and Packet Data Networks (PDN) (3GPP TS 09.61 Version 7.10.0 Release 1998)

[Security] Digital cellular telecommunications system (Phase 2+); Security related network functions (GSM 03.20 version 8.0.0 Release 1999)

[STS] Counters in the Measurement Database for GPRS Statistics, 7/155 17-CRT 240 06 Uen

[STS9.1] Counters In the Measurement Database for GPRS Statistics, 6/155 17-CRT 240 11 Uen

[TCPloss] A Passive Method for Estimating End-to-End TCP Packet Loss, IEEE Globecom 2002.

7 Invention Information

7:1 Do you know of any publication dates/deadlines for this invention?

☐ No • Yes, specify

- Date of Publication: 2003-09-01
- Type of Publication:
  - o Commercial sale or use?
  - o Marketing exercises?
  - o Publication/Conference/Customer presentation? MAGNeD research co-operation with Vodafone Group R&D
  - o Standard?
  - o Other?

7:2 Do you know the name(s) of any Ericsson expert in this field?

☐ No • Yes, specify

- Name the expert(s): Martin Skarve, GEC Sweden; Erik Westerberg, CRND; Jonas Bäckman, Global Services

7:3 Origin of your invention

The inventors work in the "Traffic analysis in GPRS/EDGE and UMTS network" research area of Traffic Lab. One important goal of this research area is to devise efficient and precise characterisation methods for the performance management of packet switched mobile data networks.

An earlier patent application covers the architecture and main functionality of the Moniq (http://www.r.eth.ericsson.se/RB/moniq/) tool.

This invention disclosure is the first full description of the invention.

The invention is related to the MAGNeD project (http://www.r.eth.ericsson.se/RL/magned/), which is a joint research project of Vodafone and Ericsson, but can definitely not be regarded as a result of this project. MAGNeD is funded by Ericsson Research, project co-ordinator from Ericsson is István Szabó.

7:4 Will this invention be incorporated into an existing/future product?

☐ No • Yes, specify

- Name the product: Moniq

Read and Understood by: [illegible] Date: 2003-08-29

Read and Understood by: ...... Date: ....

Prepared (also subject responsible if other)		Document Nr.		
ETH/RT Szabó, Borsos, Veres, Malomsoky		1/ETH/RL-2003:0133		
Approved	Checked	Date	Rev	P-Number
ETH/RTC Hans Eriksson		2003-08-28	A	

Moniq is a passive software tool providing end-to-end performance indicators and traffic statistics from monitoring subscriber traffic in mobile data networks.

- Potential customers or markets: Basically every mobile operator either by buying the tool developed based on this methodology or by buying a network improvement service, which uses the proposed methodology.
- Is this a product in an evolving market? Yes, passive measurement based network analysis becomes more and more popular among operators.

7:5 Is this invention related to any technology governed by a particular governing body including standards?

☐ No • Yes, specify

- The name of the standard: 3GPP, 3GPP2 standards describing 2.5 and 3G mobile data networks
- Is the invention related to the implementation of the standard? No, the invention is related to the performance monitoring of networks built based on these standards
- Is the invention compulsory or optional to the standard? No
- Will Ericsson submit a contribution for this invention? Not likely

7:6 Can your invention be detected when it is implemented?

☐ No • Yes, specify

- How can it be detected? Anybody claiming to building a mobility aware condensed database of user sessions and transactions from raw data captured over standardised interfaces would infringe this invention.
- Does this require much effort? Medium Effort

7:7 Do you know the names of any of Ericsson competitors in the area of your invention?

• No ☐ Yes, specify

- Name the competitor(s):

Read and Understood by: ......Pritchen Gibbon	Date: 2003-08-29
Read and Understood by:	Date: ....

ERICSSON

INVENTOR REGISTRATION

Slogan	P-Number
Advanced Performance Management of Mobile Data Networks	

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☐ **On contract from other Ericsson company than in working dept above? Which company?**	
☐ **Consultant?***	
☐ **External inventor?***	
☐ **Student writing thesis?***	
☐ **Other relationship to Ericsson?***	

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